Associations among Massage, Post-Operative Pain, Narcotic Administration, and Maternal Anxiety in Infants with Congenital Heart Disease

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Review of Literature

Congenital heart disease (CHD) is a structural abnormality of the heart or major blood vessels, occurring in approximately 9 per 1000 live births (Lloyd-Jones et al., 2010). Defects range from small holes between chambers, which may cause no adverse effects and resolve spontaneously, to complex malformations which require surgical intervention within the first year of life. Complex congenital heart disease (CCHD) occurs in roughly 25% of all congenital heart disease malformations (Lloyd-Jones et al., 2010) and refers to structural abnormalities which require intervention in the first weeks of life. A multitude of surgical interventions may be required depending on the type of CCHD. Between 2007 and 2010, approximately 20,000 neonates underwent cardiac surgery for congenital heart disease, and accounted for more than 50% of deaths that occurred during this period for all patients undergoing surgery (Krishnamurthy, Ratner, Bacha, 2013). Ultimately infants with CHD and CCHD may require multiple hospitalizations and interventions throughout their lifetime.

Infants with CCHD experience surgical pain from undergoing surgery within the first months of life. Furthermore, infants in the intensive care setting, may experience between 5 and 15 painful procedures per day (Anand et al., 2000) putting them at further risk for untreated pain. Untreated pain in infants can result in the permanent modification of pain systems because pain occurs during an important time for neurological development and maturation, leading to neuronal changes (Anand et al., 2000;Witt, 2016). Sustained infant pain can also result in the altering of pain thresholds, as well as physiological responses to stress or pain (Allergaert, 2016). Grunau (2009) found that repeated procedural pain in the preterm infant led to lower cognitive development at intervals of 8 and 18 months when compared to full term controls. Also, increased exposure to stressful procedures during an infant’s NICU stay has been associated with reduced frontal and parietal brain size and altered functional connectivity in the temporal lobes, with reduced white matter and subcortical gray maturation found in association with increased procedural pain in the neonate (Ranger & Grunau , 2014).

Management of pain during infancy is undertaken through a variety of pharmacologic and non-pharmacologic interventions. While narcotic analgesics are commonly used for pain management in the infant, their overuse can impair neurological development (Allegaert, 2016; Anand et al., 2000; Witt, 2016). There are a variety of non-pharmacological interventions currently in use as adjuncts to pharmacological intervention that do not have a negative neurological impact on infants. Non-nutritive sucking and rocking/holding are evidence-based non-pharmacological interventions to reduce infant pain (Pillai Riddell et al., 2015). However, these interventions primarily focus on acute pain in the clinical setting, as opposed to chronic pain or long-lasting pain, such as occurs following surgical procedures.

In children, massage is a nonpharmacological intervention that improves symptoms in children with cancer, including a decrease in pain, depression, and anxiety (Rodriguez-Mansilla et al., 2017). Massage therapy has also been effective in reducing pain and anxiety in adolescents with burn injuries (Parlak, Polat, Akcay, 2010) as well as a decreased pain and discomfort rating in children with chronic pain (Suresh et al., 2008). While there is limited information into the role of massage in pain management in the infant population, the type of massage most useful is well documented in literature. Studies of light massage versus moderate massage in infant populations found that moderate massage leads to more decreases in heart rate and heart rate variation, arousal, lower cortisol levels, and an increase in vagal activity compared to light pressure massage (Diego et al., 2004; Diego et al., 2009; Field 2014). In adults with rheumatoid arthritis, moderate massage was found to be more effective in pain reduction compared to light massage (Field et al., 2013). Furthermore, the effect of massage therapy on pain reduction in post-operative cardiac patients has been less studied, and has yielded inconclusive results. Research by Braun (2012) found that massage intervention following cardiac surgery in adults led to a significant reduction in pain scores and reported anxiety when compared to controls who received no massage. However, Albert (2009) found no variation between pain and anxiety scores between massage and control groups in the adult postoperative cardiac surgery patient.

Only one study was found examining massage and postoperative pain in infancy. The study examined the effectiveness of the M-massage technique on postoperative pain reduction in 59 children between 3 and 36 months old undergoing major craniofacial surgery (de Jong et al., 2012). The massage intervention was determined to be ineffective, even resulting an increased level of patient distress when compared to standard postoperative care (de Jong et al., 2012). However, the M-massage method is considered a light massage technique which may account for these results. Also, with a median age of approximately 10 months and a small sample size, this study offers limited insight into the role of massage in the infant.

Unlike the impact of massage on postoperative infant pain, the effects of parental anxiety on their child's pain has been examined more in depth. In parents of children with chronic pain due to cancer, increased parental anxiety was found to correlate with increased parental rating of child's pain severity and frequency. However, no relationship was found between child reported pain and parent anxiety levels (Link, 2016). Recent studies have found that parent modeling and display of anxious behaviors is a primary way children learn such behaviors and provide evidence as to the etiology of transfer of anxiety and fear between parent and offspring (Aktar et al., 2013; Eley et al., 2015). The similar neurological mapping of the location of both pain and fear is thought exist in humans as well. The amygdala is involved with emotional response for learned fear, anxiety and depression and new evidence supports the amygdala's role in pain response and pain behaviors (Neugebauer, 2015), whereas the parietal lobe is responsible for the sensation of pain (Garcia-Larrea, 2018).

This possible relationship between parental anxiety and a child's experience of fear and pain may be explained by a model of social learning. The social learning of fear in infants is thought to be an adaptive process; allowing offspring to learn early from parents about possible threats (Debiec & Olsson, 2017). Human infants and children exposed to a novel stimuli paired with fearful expressions, learned to display fear when exposed to the stimuli (Debiec & Olsson, 2017). Social learning has been found to exist at birth in rodent models, where infant rat pups are able to acquire responses to maternal fear cues, activating multiple areas of the pup's brain involved in processing threat, stress, and pain (Chang & Debiec, 2016). This offers potential explanation for an underlying mechanism for learning social fear and its impact on infant response and the developing brain. However, this model has only been examined in rodents. If maternal fear elicits a response in the area of an infant's brain responsible for stress and pain, an infant who identifies increased distress in their mother may present with increased pain. Furthermore, a child who learns this association during infancy may continue to exhibit this phenomenon as they develop throughout childhood.

Aside from having a direct impact on the infant, parental anxiety may have negative effects on the relationship between infant and mother. In some instances, increased levels of maternal anxiety has been found to be associated with poor mother-infant interaction (Parffitt et al., 2013). This negative interaction is thought to be a result of anxious mothers whom are more likely to overstimulate their infant (Feldman et al., 2009). This overstimulation in turn blocks the infant's own signaling and regulatory processes. However, a study of maternal depression and anxiety on infant social engagement and fear regulation found that mothers with anxiety disorders are less sensitive to their infant's cues and have less social engagement with their infant when compared to healthy controls (Feldman et al., 2009).

There are notable differences in interactions between healthy infant-mother pairs and infants with CHD. Decreased infant and mother engagement have both been found when comparing healthy infant-mother pairs and with infants with CHD and their mothers (Gardner et al., 1996; Lobo, 1992), with mothers of such infants distressed (Gardner et al., 1996). Mothers of infants with CHD are less likely to smile, make eye contact, touch, hum, or sing during feeding when compared to mothers of healthy infants (Lobo, 1992). These findings are significant because maternal sensitivity is important for the psychological development of the infant. Conversely, more recent work by Harrison (2009) suggests that mothers of infants with CCHD were more supportive and attuned to their infant during feeding compared with mothers of healthy infants.

Not only may there be differences in interaction between a mother and her child with CHD when compared to a mother and her healthy child, the mental health of mothers with CHD infants when compared to mothers of healthy infants varies significantly. A systematic review by Woolf-King (2017), including 30 articles, found that between 25-50% of parents of children with CCHD reported clinical signs of depression and or anxiety, with between 30-80% of parents reported experiencing psychological distress. Other studies however have found parents of children with CHD to have less psychological distress (Spijkerboer et al., 2007; Visconti et al., 2002). Similarly, a study of anxiety levels of parents of children with CHD at time of discharge found parents to not be anxious at the time of discharge (Flischer et al., 2012). These studies did not examine anxiety during the hospitalization or early recovery from surgery.

In summary, no studies were found that examined pain or the effect of post-operative moderate massage on pain in infants with CCHD. Also, there is limited study on massage as well as surgical and chronic pain in the infant population. While there is evidence of the impact of parental anxiety on child pain and perception of their child's pain, there is no current research on this relationship in the infant population. Furthermore, there is limited and conflicting data on parental anxiety in CCHD parents. The purpose of this study was to determine whether there is a relationship between parental anxiety levels, moderate massage, and infant pain scores in infants with CCHD. The aims of this study were to examine the association between: (a) massage and infant postoperative pain, (b) maternal anxiety and infant pain scores, (c), maternal anxiety and administration of narcotics to the infant.

Methods

Design

This pilot study was a two-group, randomized clinical trial design that examined the effectiveness of massage on pain in infants who had undergone cardiothoracic surgery within the first year of life.

Setting and Sample

The study was conducted at a large Midwestern Cardiothoracic Intensive Care Unit (CICU). Only infants with a diagnosis of complex congenital cardiac disease were included. These defects include diagnoses such as transposition of the great arteries, Tetralogy of Fallot, and any form of single ventricle heart disease. Power analysis revealed that a sample of 60 infants was required to achieve a power of 0.80 to detect a difference of 0.7 in pain scores between groups, assuming a coefficient of variation of 120% and a Type I error rate of .05.

Inclusion/Exclusion Criteria

Eligible participants were: (a) up to, but not including, 12 months of age and (b) scheduled for cardiothoracic surgery that included a sternotomy. Infants who had previously had surgery were excluded because previous exposure to surgical pain can alter pain response (Johnston & Stevens, 1996). Within the initial 48 postoperative hours, infants were withdrawn from the study if on paralytics, or were deemed unstable by CICU clinicians. The mothers or legal guardians of the infant were at least 18 years old and English or Spanish speaking.

Recruitment

Eligible families were approached by the study staff during the outpatient preoperative assessment prior to scheduled surgery. If unable to meet with the family prior to surgery, study staff approached the family in the waiting room on the day of surgery. Following informed consent, each participant was randomly assigned to one of two groups using randomization software. Group 1 received standard post-operative care plus a 30 minute restriction of non-essential caregiving for seven consecutive days; Group 2 received standard post-operative care plus a 30 minute massage for seven consecutive days.

Intervention

Massage. The massage intervention consisted of one massage given by one of the institution's licensed massage therapist on each of seven consecutive days beginning on the day of surgery (Day 0). A standardized massage therapy protocol based on principles of Swedish massage was used to ensure consistency in methods. The massage included 30 minutes of gentle friction, kneading, stroking, and passive touch on the infant's accessible upper extremities, lower extremities, head, face, and back. Standard hospital-provided lotion was used. Massage sessions were provided in the infant's hospital room beginning between 2 and 24 hours after arrival in the CICU post-surgery and continuing each day for seven consecutive days or until the infant was discharged home, whichever occurred first. If the infant was transferred to the step-down unit prior to the end of the seven day protocol, massages were continued until the protocol was completed. Massages were scheduled between the hours of 1230 and 1630. Standard precautions were used, including proper hand hygiene and the use of gloves when needed for infection control. The massage was documented on the medical record following each intervention. Although restricting caregiving activities both prior to and after the massage would have been ideal, we were unable to do so given the intensive nature of care needed in the CICU. Intrusive patient care tasks provided within 30 minutes prior and 30 minutes after the massage were identified with chart review and examined as potential confounders of study measures. The initial massage was deferred within the first 24 hours after surgery on infants on paralytics or deemed unstable by the bedside nurse. The stability of the infant were reassessed during the second 24 post-operative time period. If still on paralytics or determined to be unstable, the infant was withdrawn from the study. Massage was deferred on infants on the intervention protocol who were unstable at the time of the scheduled massage. If more than 2 massages were missed due to physiological instability, the infant was withdrawn from the study. To ensure integrity of the intervention, an experienced licensed massage therapist not providing the study intervention observed massage technique of each of the intervention therapists throughout the course of the study to test delivery consistent with agreed upon protocol. These observations occurred randomly with 20% of the 150 massages delivered during the weekdays and 20% of the 60 massages delivered on the weekends.

Quiet Time

Infants randomized to the quiet time comparison group received a 30 minute scheduled time during which non-essential, direct clinical interventions requiring physical contact were restricted. Quiet time was scheduled between the hours of 1230 and 1630. During this time period, caregivers were asked to avoid direct, non-essential, caregiving activities, i.e. activities requiring physical contact with the infant. The restricted non-essential caregiving was scheduled by the PI in consultation with the patient's caregiver, similar to the scheduling of the massages by the massage therapist.

Measures

Pain. Pain was assessed using the Face, Legs, Activity, Cry, Consolability (FLACC) Pain Assessment Tool, specifically designed to measure pain in post-operative infants and children (Merkel et al., 1997). The FLACC measures facial expression, position and muscle tone of legs, level and quality of activity, presence and type of cry, and level of consolability. Each item is scored on a 3 point (0 to 2) Likert scale and then summed with possible scores ranging from 0 to 10, higher scores indicating more pain. The FLACC has been validated for use with children from infancy through 7 years as an objective measure of pain (Merkel et al., 1997). Interrater reliability testing of the FLACC scores was accomplished by random observations of 20% of randomly chosen infants conducted by two research staff. Means of six daily pain scores were calculated and used for analysis. The inter-rater reliability for the FLACC measured using an intraclass correlation coefficient was 0.971.

Narcotic Use. Medication data were extracted from the electronic medical record (EMR) for all analgesic medications administered to patients during the study period and included hydromorphone, fentanyl, morphine, acetaminophen, ibuprofen, ketorolac, and oxycodone. The total daily medication dose was calculated as the sum of the baseline rate for continuous infusions, as appropriate, plus bolus doses in dose per kilogram weight. Bolus doses were extracted from the medication administration record and were 100% verified by 2 different research assistants. Data for continuous infusions were extracted as volumes administered in the EMR and calculated as doses administered using the medication concentration and patient weight in kilograms as follows:

[medication volume (mL) x medication concentration (dose/mL)] / patient weight (kg) = dose/kg

Data were verified on a second occasion for greater than 20% of the entries. Narcotic analgesics – hydromorphone, morphine, oxycodone – were converted to a fentanyl equivalent to directly compare narcotic doses among patients for whom different medications were used.

Parental Anxiety. Parental anxiety was measured using the State-Trait Anxiety Inventory (STAI), a widely used, reliable, and valid 40 item tool using a 4 point Likert scale with 1 = no anxiety and 4 = very much anxiety, requiring approximately 10 minutes to complete (Spielberger &Gorsuch, 1983). The Cronbach's alpha value for State-Trait Anxiety Inventory was as follows: Time 1 State = 0.930, Time 2 State = 0.948 and Time 1 Trait = 0.879, Time 2 Trait = 0.880. Time 1 STAI was used for analysis.

Severity of Cardiac Defect. Severity of cardiac defect was measured using the Risk Adjustment for Congenital Heart Surgery, a widely used, validated clinical research tool for evaluating differences in outcomes based on surgical procedures which are grouped based on similarity of in-hospital mortality risk (Jenkins et al., 2002).

Participant characteristics. Infant health information was obtained and included severity of cardiac defect, age at surgery, perioperative data, medications, and concurrent diagnoses.

Procedure/Data Collection

Following consent, parents were asked to complete the anxiety measure. Parent-infant dyads were then randomly assigned to either the intervention or control group. The 30 minute Massage or Quiet Time began between 2 and 24 hours following arrival in the CICU after surgery. The research assistants (RA) obtaining participant pain scores were blinded to study group. The RAs assessed pain on all study participants at 0800, 1200, 1600, and 2000 on each day of the seven day intervention. Additionally, each day the PI provided the RA with the time frames within which pain would be assessed pre- and post-intervention. For both groups, pain scores were obtained within 30 minutes before and within 30 minutes after the intervention/restricted time for each of the consecutive 7 study days. RAs were blinded to intervention group. At the end of the 7 day study or on the day of discharge, whichever occurred first, anxiety measures were completed by parents. Medical record data were abstracted from the chart following discharge.

Data Analysis

Descriptive statistics were calculated for demographic information and for each variable in order to describe the sample and to reveal the distribution. A preliminary examination of the data was conducted to test for distributional assumptions. The level and sources of missing data were examined. For two group comparisons, Chi-square or Fisher’s exact tests was used for categorical variables, and two sample t-tests were used for continuous variables. Non-parametric comparisons were used if the data was not normally distributed. Using group-based trajectory modeling, two models were used to classify the sample by trajectories of pain scores and of narcotics use. These group trajectory classifications were then used as an outcome measure in logistic regression models using the following predictors: group, sex, age at surgery, numbers of days on narcotics, severity of disease, and mother's anxiety level on day of surgery. Type 1 error rate was set at 0.05.

Results

Sixty-five infant-parent pairs were recruited over a 15 month period. Five mother-infant dyads were withdrawn from the study; 1 participant expired before surgery could be done, 1 dyad was randomized to the control group and wanted intervention, 1 was inappropriately recruited (not meeting criteria because they previously had surgery), 1 infant did not meet parameters at time of data collection due to delay in surgery resulting in infant > 12 months old, and 1 infant was too agitated per bedside nurse to receive massage intervention for the first 48 hours following surgery. The final sample consisted of 60 subject pairs, with 30 in the control group and 30 in the massage intervention group. Patient characteristics are reported in Table 1. Pain scores did not differ by group except on day two (t = -2.145; p = 0.036; see Table 2). Otherwise, groups did not differ on any of the characteristics or study variables, including parental anxiety (see Tables 1 and 2).

The 2-class pain trajectory model revealed 83.21% of infants had stable low pain scores (Class 1), and 16.79% had initial high scores that gradually dropped (Class 2; see Figure 1). Infants likely to be in Class 2 had mothers with higher anxiety (OR = 5.34, CI = 0.96, 29.72), were in the massage group (3.25, CI = 0.53, 20.08), and were male (OR = 0.70, CI = 0.14, 3.55). The 2-class narcotic model revealed 85.00% had a low, stable trajectory (Class 1) and 15.00% had an inverted-U trajectory (Class 2; see Figure 2). Infants likely to be in Class 2 had mothers with higher maternal anxiety (OR = 1.59, CI = 0.48, 5.32), were in the massage group (OR = 3.82, CI = 0.67, 21.57), and had more severe disease (OR = 3.80, CI = 1.09, 13.31).

Discussion

This study examined relationships among moderate massage, postoperative pain, narcotic administration, and maternal anxiety in infants with CCHD who had undergone cardiac surgery.

Our most important finding was the relationship between maternal anxiety and both infant pain scores and narcotic administration. Findings revealed a subset of approximately 17% of the total sample had higher pain scores within the first 3 days of the study (see Figure 1). Members of this class were most likely male, in the massage group, and had mothers with higher anxiety, compared to the rest of the sample. This finding suggests there may be a subset of infants with CCHD for whom postoperative moderate massage is not an effective non-pharmacological pain intervention, and possibly even causes more distress in the infant and thus higher pain scores. Similarly, a class of 15% of infants (n=9) who received higher levels of narcotics were likely to have mothers with higher maternal anxiety, be in the massage group, and have a higher disease severity (see Figure 2). It is possible that increased levels of maternal anxiety was related to increased infant pain scores and subsequent narcotic administration in postoperative CCHD infants. The findings of increased maternal anxiety and narcotic administration identified in the 2-class narcotic model may also be due to mothers of CCHD infants with higher severity having higher anxiety as a result of their child's more serious illness. The 2-class narcotic model had an inverted U trajectory due to low narcotic administration on Day 0 for both classes of infants. However from Day 1 on, the Class 2 infants in the model had significantly higher narcotic administration that trended downward in a linear fashion. This finding may be attributable to less narcotics being needed immediately postoperatively because anesthetics used intra-operatively could have led to lower observed expression of pain postoperatively. All of the FLACC behavioral codes could have been affected by analgesics.

Removing Day 0 narcotic use from the model would result in a stronger, more linear relationship in the narcotic model, similar to the Class 2 pain model.

With the exception of Day 2, our study did not find difference in pain scores between infants receiving massage and infants receiving Quiet Time (see Table 2). On Day 2 the massage group had significantly higher daily pain score average ($p < 0.05$) compared to the Quiet Time group. This may suggest that moderate massage is not effective in reducing pain in the postoperative CCHD infant. It is also possible that our control condition of Quiet Time may have acted as a period of time where the infants used their own regulatory processes to manage physiological stress, thus influencing pain scores.

Overall, the pain scores were reasonably low, indicating adequate pain control in these postoperative infants. However, the importance of finding non-pharmacological alternatives to pain control in this population is evident by the high narcotic administration in Class 2. Rather than an overall difference between massage and Quiet Time group, a subset of the infants, primarily randomized to the massage group, were found to have higher pain scores, greater narcotic use, and greater severity of disease and had mothers with higher anxiety. This may have been because the impact of increased severity of clinical presentation and or increased maternal anxiety on infant pain may have outweighed the benefit of moderate massage. While there was no difference between groups, our findings contribute to the literature about massage in infants with CCHD.

This is the first study to date to investigate maternal anxiety in relation to infant pain and narcotic administration. Maternal anxiety scores did not differ between groups and State anxiety scores were reduced from Time 1 to Time 2 as would be expected. Our findings revealed higher maternal anxiety was present in infants who had higher pain scores and who received more narcotics (Class 2). More research is needed on maternal anxiety and its potential relationship between infant pain and narcotic administration. These associations between maternal anxiety and infant pain and narcotic administration may be due in part to higher anxiety in mothers of CCHD infants with more serious illness. These findings have clinical implications for nursing practice related to addressing and reducing maternal anxiety as a nonpharmacological intervention for pain management, aiding in infant pain reduction and decreased narcotic administration.

It is difficult to measure pain in infants because the population is non-verbal, pain is subjective, and there is no standard universal approach. A variety of methods for assessing pain exist and examine a multitude of different factors, including but not limited to changes in heart rate, respiratory rate, blood pressure, salivary cortisol, facial expressions, crying, arousal and overall behavior (Witt, 2016). However, these observations are not specific to pain in the infant, and could also signify distress or agitation rather than pain. Infant's gestational age, sleep-wake state, severity of illness, recent duration of and exposure to pain are all factors that affect infant pain responses. A systematic review by Hatfield and Ely (2015) that examined the validity and reliability of variables used in the assessment of infant pain found that while heart rate, oxygen saturation, facial expression and body movement were all strong measures of infant pain, the reliability of infant cry needs to be further investigated because some infants cry during or after a painful procedure while others do not. Also, body movement in response to pain is more difficult to determine in preterm or acutely ill infants (Gibbins & Stevens, 2003). These infants are often unable to sustain a behavioral response to pain, which challenges our ability to appropriately measure long term pain in the infant (Hatfield & Ely, 2015). It is possible that our study, which assessed for infant cry and activity as part of the FLACC pain assessment tool, was misidentifying pain in the infant due to the limitations of currently available pain scoring tools. While the FLACC was developed and tested to measure postoperative pain, its initial validity and reliability was tested on children between 2 months and 7 years of age, with a median age of 3 years (Merkel et al., 1997). It is possible that this measure was not as accurate in measuring pain in our study's younger sample size. There is some support for the sensitivity and specificity of the FLACC in postoperative infants less than 12 month old (Ge et al., 2015). However this analysis was only performed on infants in the post-anesthesia recovery room, and a search of current literature has revealed no reports on the evaluation of FLACC in assessment of prolonged postoperative pain in infants.

Our study was limited by large confidence intervals of both the pain and narcotic models. Furthermore we only collected one anxiety measure, once before the surgery and once at the end of the study. Daily maternal anxiety measures would have provided further insight into the role of maternal anxiety in CCHD infant postoperative pain and narcotic administration by enabling a more direct, daily comparison among these factors.

Our findings suggest that maternal anxiety may be associated with both pain and narcotic administration. This suggests that interventions to reduce parental anxiety may be a potential approach to reducing infant post-operative pain. Further research is needed to determine the impact of moderate massage on the postoperative infant. Additional research is also needed to examine associations of pain in infants with CCHD and maternal anxiety as well as massage, disease severity, and infant characteristics. Clinical outcomes for nursing practice include addressing maternal anxiety as a noninvasive and nonpharmacological intervention to reduce pain, and subsequently reduce narcotic administration in the infant following surgery.

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Table 1
Infant Characteristics[a]

		Quiet Time n (%)		Massage n (%)	
Female Sex		18 (60.00)		17 (56.67)	
Single Ventricle		9 (33.33)		5 (16.67)	
Cardiac Defect	ASD	2 (6.67)		2 (6.67)	
	AV Canal	3 (10.00)		0 (0.00)	
	VSD	5 (16.67)		6 (20.00)	
	HLHS	5 (16.67)		4 (13.33)	
	TGA	3 (10.00)		6 (20.00)	
	TOF	5 (16.67)		4 (13.33)	
	Misc.	7 (23.33)		8 (26.67)	
		Mean	SD	Mean	SD
Age at Surgery (days)		101.00	114.50	90.00	90.79
Length of Stay (days)		21.27	31.09	19.47	19.01
RACHS (severity)		2.83	0.79	2.70	0.79
STAI T1[b]	State	2.50	0.62	2.44	0.68
	Trait	1.69	0.42	1.66	0.34
STAI T2[c]	State	1.70	0.59	1.72	0.58
	Trait	1.63	0.42	1.59	0.35

Note. RACHS=Risk Adjustment for Congenital Heart Surgery, STAI=State-Trait Anxiety Inventory, [a]Comparisons calculated using 2 sample T-Test; did not differ among group. [b]Time 1 = Day of Recruitment, [c]Time 2 = Day 6 (end of study), ASD = Atrial Septal Defect. AV Canal = Atrioventricular Canal. HLHS = Hypolpastic Left Heart Syndrome. Misc. = Miscellaneous (Anomalous Right Coronary Artery, Aortic Arch Hypoplasia, , Cardiac Tumor, Descending Coarctation of the Aorta, Double Inlet Left Ventricle, Ebstein's Anomaly, Interrupted Aortic Arch, Pulmonary Stenosis, Pulmonary Valve Stenosis, Total Anomalous Pulmonary Venous Return, Tricuspid Atresia, innominate artery compression of the trachea). TGA = Transposition of the Great Arteries. TOF = Tetralogy of Fallout. VSD = Ventricular Septal Defect.

Table 2
Infant Pain Score and Narcotic Administration

Characteristic		Descriptive Statistics			
		Quiet Time		Massage	
		Mean	SD	Mean	SD
Day 0	Pain[a]	1.776	1.805	1.886	2.046
	Narcotic[b]	13.30	8.076	15.10	8.653
Day 1	Pain	1.353	0.932	1.322	0.930
	Narcotic	21.54	21.34	30.76	32.94
Day 2	Pain*	0.871	0.793	1.429	1.184
	Narcotic	9.788	21.45	17.83	32.49
Day 3	Pain	1.169	1.186	1.146	0.911
	Narcotic	6.854	20.30	12.94	23.40
Day 4	Pain	1.198	1.074	0.946	0.938
	Narcotic	6.005	18.72	13.13	24.73
Day 5	Pain	1.258	0.880	1.160	0.780
	Narcotic	6.940	17.18	13.18	25.83
Day 6	Pain	1.213	1.105	1.150	1.128
	Narcotic	5.691	16.79	10.15	19.85

Note. [a]Pain scored using Face, Legs, Activity, Cry, Consolability (FLACC) Pain Assessment Tool. [b]Narcotic analgesics (hydromorphone, morphine, oxycodone) were scaled to a fentanyl equivalent to directly compare narcotic doses.
*$p < 0.05$.

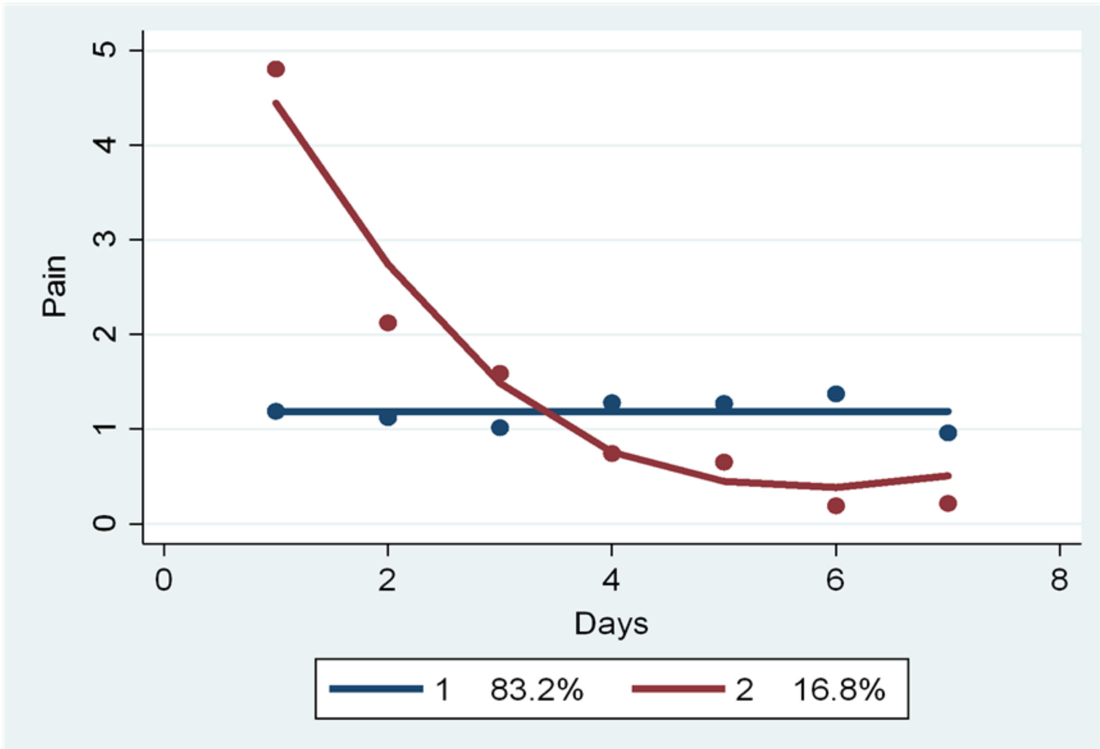

Figure 1. Group-based trajectory for infant pain.

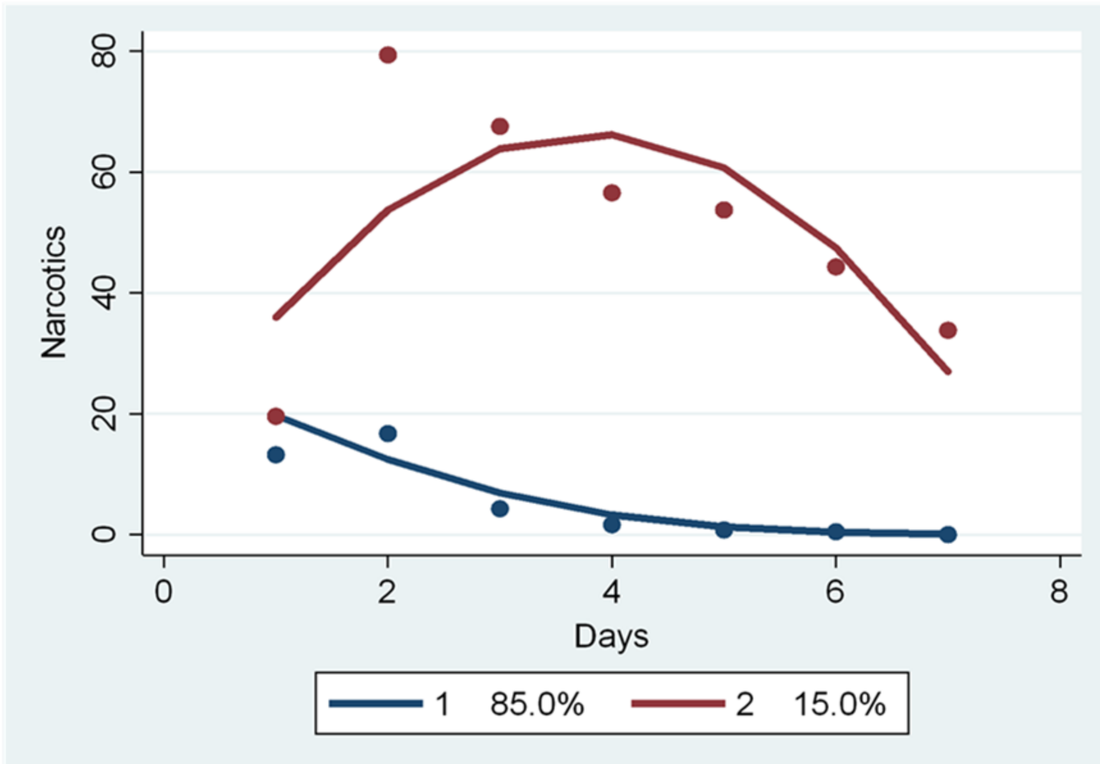

Figure 2. Group-based trajectory for narcotic administration.